UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8
1595 Wynkoop Street
Denver, CO 80202-1129
Phone 800-227-8917
www.epa.gov/region80

Ref: EPR-ER

MEMORANDUM

SUBJECT: Mine Site Category Determination for Fiscal Year 2017 Planned Activities

Removal Assessment of American Tunnel Bulkhead #3, Bonita Peak Mining District NPL Site

FROM: Paul Peronard, OSC; Kerry Guy, OSC; Rob Parker, RPM, Ian Bowen, Hydrogeologist James Hanley, regional mining coordinator

THRU: Laura Williams, Dave Ostrander, Stan Christensen, Bill Murray

TO: Sandy Stavnes, Betsy Smidinger, BPMD Site File

This memorandum is written to the file as documentation of the Mine Site Category activity determination required by the EPA OLEM memorandum (James Woolford/Reggie Cheatham, 4 April 2017).

Conceptual Site Model

The concept of the overall nature of groundwater and mine water interaction continues to evolve as integrated project delivery teams plan and complete removal assessments and remedial investigations of the predominant features controlling groundwater flow regimes and the resulting risks at this NPL Site. Four projects have been planned, and in some cases, already implemented, to understand the Site hydrogeologic characterization of the Cement Creek Basin portion of the Site. Activities at Gold King Mine, Red & Bonita, the Mogul/Grand Mogul Mines, and the American Tunnel are ongoing to characterize their relationships to the Sunnyside Mine pool of impounded water. The scope of this memo is limited to planned activities within the American Tunnel from its portal to a distance of 375 feet where Bulkhead #3 can be reached. Figure 2 from the Deere & Ault technical consultant's report provides a cross section of the American Tunnel showing the placement of the existing bulkheads; Bulkhead #3 is the first one encountered when entering the Tunnel and was the final one constructed.

Geology in the upper Cement Creek area is in the Silverton Caldera, part of the San Juan volcanic field. The Gold King, Red and Bonita, and American Tunnel are all in the Burns member of the Silverton Volcanic sequence. The Burns member consists mostly of latitic tuffs and intermediate lava flows made of porphyritic dacite, rhyodacite, rhyolite, andesite, and trachyandesite. These rocks are frequently hydrothermally altered to a much weaker propylitic mineral assemblage. The lower North Fork of

Cement Creek below the Gold King Mine is entirely within fractured latitic tuff of the lower Burns member. The stiffness of the tuffs has resulted in a widespread, systematic fracture pattern in the rock mass, especially near the surface. The fractures are generally tight, closely spaced and persistent. They generally become tighter and more widely spaced with depth where only the master joints and other large discontinuities contribute to the rock mass properties.

Other Bulkheads in the Area. Multiple bulkheads have been installed in the District beginning in 1994. Four structures on the F and B Levels in the Sunnyside Mine isolate the mine pool from the Brenneman and Mogul Mines. Besides the three-bulkhead system in the American Tunnel (1996-2002), the Terry Tunnel has two bulkheads isolating the Sunnyside Mine from the upper Eureka Creek drainage. The Mogul Mine bulkhead was installed in 2003. EPA constructed a bulkhead in the Red & Bonita Adit in 2015 but has not closed its valve pending evaluation of the predicted effects of storing MIW behind this bulkhead.

Piezometer Data. A vertical piezometer (NFCCPZ-1) was installed in the fracture zone along the North Fork of Cement Creek just below the Gold King tailings pile in late 2016 to understand the hydrogeology of the North Fork fracture zone and its hydraulic connection to the American Tunnel. This borehole instrument sensor was designed to provide relevant data on fluctuating groundwater levels that could be correlated with American Tunnel flowrates. Another vertical piezometer is planned to be deep and accurate enough to intercept the American Tunnel somewhere between Bulkheads #2 and #3. This planned activity is the subject of a separate consultation package.

Although NPCCPZ-1 was equipped with a water level pressure transducer, data logger, and telemetry system to send water level data to EPA, the telemetry system did not survive the 2016-2017 winter. Until recovery and repair of the system this summer, piezometer data is not available.

3-Dimensional Digital Model. Autodesk Civil 3D and earthVision software have been used to visualize this complex physical world of interconnected mine openings and regional geologic faults. The digital model incorporates the orientations of dominant faults, and all the existing mine workings using the USGS National Elevation Dataset digital elevation model for the surface topography. The elevations of the bulkheads installed in each mine are represented, along with the elevations of the seeps and springs database. Data describing known hydraulic pressures, including seep elevations, measured bulkhead pressures, porewater pressures from piezometers, and historic mine pool estimates can be stored in this spatial model for trend analysis and to support hypothesis testing and evaluation of alternative courses of action.

Observations from the proposed American Tunnel bulkhead #3 inspection activity will be used to analyze data obtained from currently completed or planned removal assessment studies:

- Future piezometer installation to be completed behind American Tunnel bulkhead #3
- Recently installed Mogul Mine bulkhead pressure gauge
- NFCCPZ-1 piezometer installed near the fault zone at the GKM Level 7 waste rock pile.

Bulkhead #3 Investigation

Some of the most critical mining structures in the BPMD NPL Site area are the three bulkheads in the American Tunnel. Bulkhead #1 was designed to control the Sunnyside Mine pool. Bulkhead #2 was designed to control inflow from the wet fracture zone or hinge fault that manifests itself as the North Fork of Cement Creek on the surface. Bulkhead #3 was designed to impound minor flows within the first section of the tunnel. The three bulkheads work together to form a supportive system reducing the pressure gradient and controlling the release of impounded water to manageable flowrates. The cause of EPA concern with the system is the relative uncertainty associated with the information in the as-built bulkhead construction and maintenance records and the current inability to directly inspect the mechanical integrity of these important underground concrete structures.

According to EPA technical consultants, the most likely failure mode of a bulkhead is seepage and piping. Piping is the undesired development of water flowpaths around the bulkhead due to the displacement of small soil and rock particles transported by erosive water velocity. Piping starts small but can increase the size of the natural fracture patterns resulting in excessive seepage. Excessive seepage past a bulkhead occurs when the higher upstream pressure finds fractures in the downstream rock mass or concrete-rock interface that bypasses the bulkhead. The worst case would be where the pressure gradient and seepage is high enough to wash out material in joints, leading to a significant piping failure. Seepage and piping is a direct function of the pressure gradient across the bulkhead.

For Bulkhead 3, the construction certification report states that … *the construction pipe was permanently closed on December 3 2002 and additional formation grouting was done downstream of the bulkhead for the remainder of the week. Very little grout was accepted [injected] during this process*." The report does not provide technical information regarding grout locations, drill hole depths, quantities, and effectiveness in reducing flows. The report also does not state whether geologic formation grouting was carried out to close visible joints, stop dripping water, or conducted until grout could no longer be pumped into the surrounding rockmass. EPA technical consultants do not have sufficient information to make any further evaluation of mechanical integrity. Sunny Side Gold report (2003b) states "*The portal was closed but because of seepage downstream of the American Tunnel, the No. 3 Bulkhead was reopened to determine if Sunnyside could provide assistance to Gold King in reducing the seepage…*". What additional rehabilitation work on Bulkhead #3 that may have been carried out is unknown. This uncertainty regarding the mechanical integrity of the bulkhead could be reduced if the downstream side of the bulkhead and adjacent tunnel conditions could be visually inspected. Following acceptance of bulkhead construction by the State of Colorado as partial fulfillment of obligations under a 2002 consent decree, the American Tunnel portal was backfilled and closed in accordance with the final surface reclamation plan. The portal has been partially backfilled around a 24-inch diameter HDPE drainage culvert with uncompacted, blasted rock material inserted from the original entrance for an unknown length towards the face of Bulkhead #3. This culvert preserved positive drainage so that water pressures could not build up within the fill. This fill currently restricts direct access for technical observation.

Flow measurements at the American Tunnel portal have averaged around 110 gpm since 2005 with no significant trends up or down from 2005-2016. The source of this water is not known. A line of evidence

supporting the ongoing integrity of bulkhead #3 is that the flows have remained relatively steady despite the increasing amounts of infiltration and snow melt and the increasing flows from other adits at the BPMD Site.

EPA technical consultants report that the American Tunnel bulkheads are unlikely to fail in a catastrophic manner. If water pressures increase more than expected, the most likely consequence would be increased seepage past the bulkheads and through the rock mass. This increased seepage would express itself as increased drainage from the American Tunnel portal. Loss of mechanical integrity in the American Tunnel Bulkhead #3 presents a considerable source of fluid hazard and a significant consequence of failure for the three-bulkhead system. The most plausible failure mode would be rapidly-increasing seepage or piping past the bulkhead, possibly through joints or shears in the rock mass, resulting in uncontrolled releases at the portal.

The uncertainty associated with evaluating the true risk can be addressed by establishing access to the Bulkhead #3 from the portal and conducting visual inspections initially with remote-controlled cameras, and later by professional engineers making direct observations and mechanical tests of the bulkhead integrity.

Adit Flow monitoring. Flow measurements from Red & Bonita are not yet available in 2017, however the flow from Gold King has dropped slightly after peaking in September 2016. Steadily increasing flows strongly suggest a rising groundwater elevation inside the mountain draining the Red & Bonita and the Gold King Mines. This trend is possibly in response to a lagged groundwater recharge response after a return to higher and more normal levels of precipitation following the drought cycle from 2010-2013.

Planned Activities in 2017

Tunnel investigation and remote inspection. Routine underground construction activities will be taken in the American Tunnel sufficient to examine the condition of the internal 24-inch diameter drainage culvert with remote-controlled cameras. Blasted rock fill will be removed from the Tunnel with roof support installed as needed for safe passage. The condition of the bulkhead face and tunnel conditions immediately in front of the bulkhead will be closely evaluated and then monitored on an annual basis.

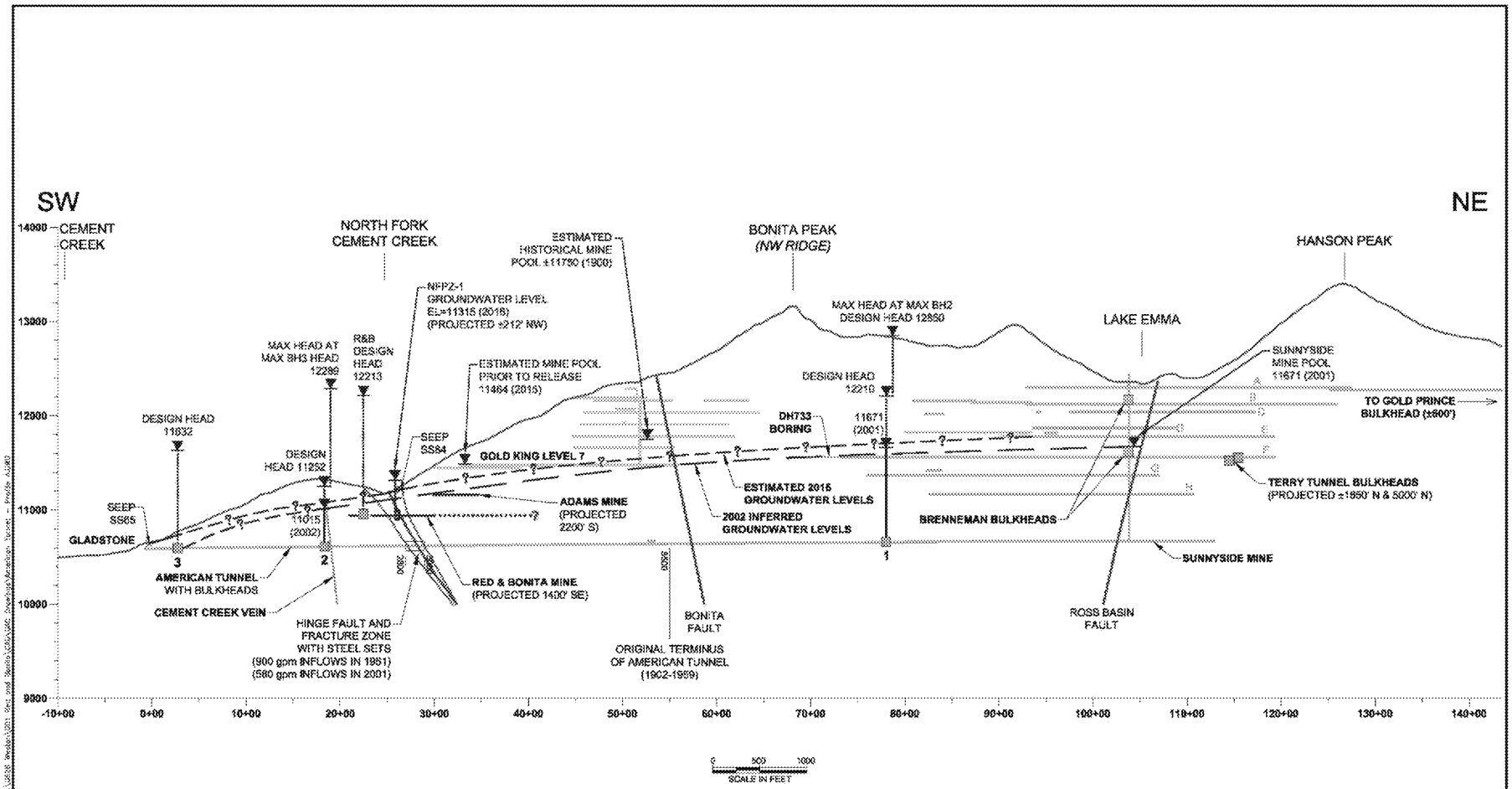
Water in mine tunnels can be released via piping that bypasses existing bulkheads, temporary flow structures, cofferdams, or unintentional tunnel roof collapses during rehabilitation. Bulkheads stop or limit the flow of water from a mine tunnel and act as an underground dam with all the similar hazards that exist for these as for surface dams. However, the work to be performed during 2017 is intended only to provide visual examination of the mechanical integrity of Bulkhead #3 and its immediate supporting rockmass structure.

If flows surge during this examination (beyond the current steady-state rate of 110 gpm), higher drainage rates would be managed by the construction dewatering system without spilling from the American Tunnel portal.

Construction dewatering system. An expedient water conveyance (ditch or pipeline) will be installed prior to investigating the American Tunnel and operated to transfer excessive drainage emanating from the portal to the Gladstone Industrial Water Treatment Plant (IWTP). The temporary drainage conveyance will be installed to take American Tunnel (AT) water from its current discharge ditch and reroute the flow into the upper pond at the Gladstone IWTP. Sufficient additional storage capacity at the Gladstone IWTP is available to process this temporary increase in flow that might develop during the American Tunnel backfill clearance and Bulkhead #3 inspection. The pond system in the northern portion of Gladstone is built to accommodate short-term storage or temporary treatment of the flows from American Tunnel. These ponds consist of two, 60-mil HDPE geomembrane-lined, cells separated by an earthen dam with a spillway and a 12-inch pipe with valve one-foot above the bottom of the pond surface. The water level is kept at a low level so the ponds currently act as a surge retention system for the interim water treatment plant, and provide up to 6 hours' storage at 500 gpm flow (180,000 gallons) for planned temporary shut-down of the IWTP. The IWTP at Gladstone was designed and is operated by Alexco Environmental Group. The plant includes two working clarifiers and sufficient filter bag capacity to maintain operational compliance with peak flows up to 1,200 gpm. A temporary settlement pond will be excavated near the AT portal to trap 75,000 gallons of sediment-laden tunnel water so that clear water can be decanted and introduced into the conveyance to the IWTP ponds.

The memorandum provides sufficient lines of evidence to warrant a "2-N" (Low fluid release risk-Nonhazardous consequence) for this removal assessment of a leaky bulkhead in the American Tunnel planned for summer 2017. Consultation with OLEM is not required prior to initiating the planned activities for 2017.

Figures



NOTES:

1. MINES FROM 3D CAD MODEL USING CDRMS GIS DATA.
2. PROFILE A IS ALONG THE AMERICAN TUNNEL APPROXIMATELY PARALLEL TO THE GOLD KING AND DAVIS VEINS.
3. 1900 ESTIMATED SUNNYSIDE MINE POOL FROM MARKS, 1917.
4. EXISTING GROUND SURFACE FROM USGS DIGITAL ELEVATION MODEL.

JOB NO. 9281.003.01

BONITA PEAK MINING DISTRICT

American Tunnel Profile A

DEERE & AULT CONSULTANTS INC.

FIGURE NO. 2

DATE: MAY 2017

SCALE: AS NOTED

	Category N (No EPA actions that would increase fluid hazard)	**Category H** (Fluid Hazards impacted by EPA actions)
Category 1 Sites with no known water in the mine, or sites containing fluids with no or low fluid hazard	Gilt Edge, Milltown Reservoir Sediments, ACM Smelter and Refinery, Anaconda Aluminum Columbia Falls, Anaconda Smelter, East Helena, Libby, Mouat Industries	
Category 2 Fluids exist but fluid hazard is not sufficiently characterized or is unknown	**Bonita Peak: American Tunnel Bulkhead #3 Inspection**; North Fork Cement Creek Piezometer-1 installation (completed); Mogul Mine bulkhead pressure transducer (completed) California Gulch, Captain Jack, Central City, Eagle, Standard, Summitville; Barker-Hughesville Block P Complex, Basin, Carpenter-Snow Creek, Silver Bow Creek /Butte,	American Tunnel interceptor borehole, Nelson Tunnel, Upper Tenmile
Category 3 Sites that have a known or probable fluid hazard		GKM Level 7 Phase II; Flat Creek IMM